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AUTHOR Grabe, Mark; And Others
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ABSTRACT

This document reviews the Phase Achievement System (PAS), a mastery-oriented instructional method, being utilized to teach biology at Iowa State University. The system is designed to reduce student failures from competitive, nonrepeatable examinations and presents course content material in a modularized form. A comparison with traditional lecture instruction is made. (SL)

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Evaluation of the multidimensional affective consequences of traditional and mastery instruction.

Mark Grabe
University of North Dakota

Mike Latta
Drake University

Warren Dolphin
Iowa State University

SE 023 975

Evaluation of the multidimensional affective consequences of traditional and mastery instruction.

Student classroom performance is typically evaluated through a fixed number of nonrepeatable, competitive examinations. Many educators have begun to question such a system both as a method of instruction and an aid to learning. The competitive nature of the examination procedure is partially at fault. Because knowledge is evaluated relative to the scores of other students rather than against fixed standards, a student with mediocre ability or poor precourse preparation may be frustrated by his inability to demonstrate an acceptable level of performance. Secondly, the competitive nature of the examinations may be debilitating to students who have adequate ability, but have difficulty coping with the anxiety-arousing nature of the evaluations. Aside from the competitive nature of the tests, their rigid and nonrepeatable scheduling may hamper learning. College students must cope with a great number of personal and academic demands upon their time. Often, they take examinations without adequate preparation. In such cases, the strictly scheduled course then pushes students onward into new material giving little incentive for the mastery of material already tested.

Although not a panacea for all of the problems affecting large lecture sections, mastery-oriented instructional systems are designed to offset most of the difficulties just mentioned. As evidenced by a recent article in Science (Kulik, Kulik and Carmichael, 1974), such teaching methods have been having a great impact on college-level science education. The Phase

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Achievement Systen (PAS) (Dolphin, Franke, Covert and Jorgensen, 1973), developed to teach introductory biology at Iowa State University, is one example of a mastery-oriented teaching technique and is the basis of this comparison of traditional and mastery systems.

PAS features preset grading standards, repetitive testing and modularized course content. Lectures are combined with a study guide stressing behavioral objectives and a tape library for review. Exams over any of the required nine phases (units) can be taken in any order and up to five times. The best score on a given unit examination is used in determining student grades. Grades are awarded by a fixed grading policy which requires a minimum average (53%) on a minimum number of phases (8) before a final average is calculated. Once these minimum thresholds have been achieved, the final grade is determined solely by quality of performance. An average of 85-100% constitutes and A, 76-84% a B, 67-75% a C, and 53-66% a D. Students passing at least six, but not eight phases, receive an incomplete and are given an additional quarter to bring their performance up to threshold levels. To alleviate problems due to the magnitude of secretarial chores, test generation and all record keeping is accomplished by computer. Total cost for this service is about eight cents per student per quarter.

The present research contrasts the affective consequences of PAS and a traditional method of instruction. Here, traditional is defined as a lecture approach with performance evaluated through four equally weighted competitive examinations. For the comparison, data from 99 males and 92 females enrolled in a PAS section were compared with data from 102 males and 92 females from a traditional section.

Affective reactions to instructional methods and subject matter have been cited as a positive benefit of the mastery method of instruction (Kulik, et al., 1974). Unfortunately, data to support these claims have come from very simple instruments - usually a single item. Because the impact of any instructional system is multidimensional, comparisons made between systems should evaluate as many facets of course impact as possible. Positive consequences in one particular area may be offset by negative consequences in other areas. Our evaluation procedure attempts to take a global look at reactions to mastery and traditional instruction and also to compare these two systems on more specific dimensions.

The original scale (see Appendix 1) was constructed in the following manner. Based upon a thorough review of the mastery-learning literature, we gathered a group of statements thought to reflect the positive and negative consequences of mastery-oriented courses. Scale items were then constructed to approach these topics. To control for response set, items were counterbalanced for positive affect. Additional unrelated items were included on the questionnaire to obtain information unrelated to this research topic. These items and several others showing low interitem correlations were excluded prior to the factor analysis.

Because the questionnaire was administered across subjects (Sex x Method of instruction) expected to differ in their responses to the items, a method to remove between-cell variation was utilized. Sum of squares and cross-product matrices were computed within cells and then pooled. The correlation matrix produced from this procedure gives the best indication of the factor structure for the total population of students responding to the questionnaire. A principle components factor analysis rotated to varimax criterion of simple structure was then employed. The solution yielded 5 factors (21 items) and was judged to be adequate according to the

following criteria: a) 55% of the variance among items was accounted for by five factors, b) eigenvalues for these five factors were all greater then one, c) items tended to load on a single factor and d) high item communalities were produced. The five factors were labelled study habits, general evaluation, tests and grades, perceived freedom, and intellectual value. Items loading on each of these factors are indicated on the handout depicting the rotated factor matrix. Underlined loadings are used to designate the items defining a given factor.

In order to evaluate the affective consequences of the traditional and mastery courses, subscale scores were constructed for each student. The five subscale scores indicate the average raw scale values for items loading on each factor. For example, a student's score for Perceived Freedom consisted of the average of his responses to questions 23 and 26. All questions that were negatively keyed were reflected prior to the formation of subscale scores.

A METHOD by SEX MENOVA was performed employing the subscale scores as correlated dependent measures. The results indicated a highly significant effect of METHOD, $F(5,411)=14.69, p \leq .001$, with PAS being evaluated more positively by both male and female students. Univariate ANOVAs performed on each subscale indicated that this effect was primarily due to the perceived Freedom and Tests and Grades factors ($p \leq .001$). The same direction of effect was observed on the other factors, but these differences did not reach an acceptable level of statistical significance.

DISCUSSION

The results of this investigation suggest an advantage for the mastery-oriented method of instruction. The questionnaire results indicated that students found the noncompetitive evaluation system and the opportunity to

achieve through diligence to be the major advantages of the Phase Achievement System. Such findings support claims made by many authors advocating the mastery method.

Aside from the data which it has provided, the assessment tool developed here provides a major step forward. Although the evaluative instrument is still at a crude level of development, it does provide a major advance over the simple instruments which have preceded it. Future efforts might be devoted to adding items which would load on those factors defined by only a few items or to the application of this assessment technique to other comparisons of traditional and mastery methods of instruction.

BIBLIOGRAPHY

Dolphin, W., Franke, R., Covert, F. & Jorgensen, C. The phase achievement system: An instructional management system for large enrollment lecture sections. American Institute of Biological Sciences Education Review, 1973, 2, 24-27.

Kulik, J., Kulik, C. & Carmichael, K. The Keller plan in science teaching. Science, 1974, 183, 379-383.

Rotated Factor Pattern Matrix for the Scale
to Measure Affective Reactions to Instructional Systems

Question Number	Study Habits	General Evaluation	Tests and Grades	Perceived Freedom	Intellectual Value	h^2
17	**.4107**	-.2793	-.3640	.1409	.1605	.4248
21	.1409	.1365	**.6911**	.0547	-.1380	.5381
23	.1307	.0803	.3659	**.5874**	-.1126	.5151
24	.2499	-.1269	**-.6249**	-.2807	.1728	.5777
25	.1258	-.2525	**-.6030**	-.1976	.0970	.4917
26	.1681	.0449	-.3468	**.7307**	-.0968	.5758
27	.1373	**.5983**	.1488	.0803	-.1035	.4160
28	.0815	**-.4207**	-.2763	-.0069	.3861	.4091
31	-.1888	-.2164	-.1567	-.1001	**.6510**	.5408
33	-.0495	.2574	-.3334	-.2373	**.4997**	.4858
34	-.0302	-.1271	**-.6961**	.0520	.2051	.5464
35	-.1005	.1307	**-.3965**	.3701	.4482	.5223
36	.0456	**.6961**	.0930	.1136	-.4219	.6862
37	.1058	**.4068**	-.0204	.1797	**-.5666**	.5304
41	.0409	-.1120	**-.6760**	.0846	.1937	.5158
42	.4800	**.5987**	.1579	-.0468	-.1776	.6474
43	**.7340**	.3124	.0078	.2046	-.0446	.6802
44	**.6649**	.3080	.0224	.1763	-.0684	.5732
45	.0022	-.2020	-.1888	.1836	**.5852**	.4526
46	.4625	-.2070	.1857	-.1975	**.3967**	.4875
47	.1593	-.1441	-.2153	-.0730	**.6805**	.5612
48	.1293	**.7400**	.2334	.0107	-.2006	.6592
49	-.0727	**-.4786**	-.3111	-.0943	.5660	.6605
50	.1272	-.2792	-.1317	-.0966	**.7152**	.6324

The underlined loadings are considered to define the factor.

Biology 101 Course Evaluation Questionnaire

We feel that the real use of an evaluation is to improve the course for future students. For that reason, we would like to use your experience in this course as the basis for evaluations which may strongly influence how we structure the course in the future. Try to divorce your opinions of the course, subject material, instructor and text as you answer the questions.

Identifying Information

Before you answer any of the questions on the Questionnaire, complete the following: (1) Print your name on the answer sheet, (2) record a lecture section identification number in the following way. At the upper right of the answer sheet is a block labelled identification number. In the first row in the column indicated by the arrow, place your section number according to your lecture time as indicated below.

Sec. No.	Day and Time
4	MWF 11:00-11:50
5	MWF 12:10-1:00

(3) now in the column beneath the section number record your social security number, (4) encode your section and social security numbers by pencilling in the slots corresponding to the numbers in the column. (5) Leave all other identifying information blank.

Please use the following scale to indicate the degree of your agreement or disagreement with each of the opinion questions on the following pages. Mark your answers on the IBM answer sheet. Be sure the number of the statement agrees with the number on the answer sheet. Make your marks heavy and black. Erase completely any answer you wish to change. Do not leave any blank spaces.

9 = very strong agreement
8 = strong agreement
7 = moderate agreement
6 = slight agreement
5 = neither agreement nor disagreement
4 = slight disagreement
3 = moderate disagreement
2 = strong disagreement
1 = very strong disagreement

These questionnaires will be analyzed by an independent agency after course grades are awarded. Please be honest in your responses.

Background Information (Factual information; Choose appropriate response)

1. Class standing: (1) freshman; (2) sophomore; (3) junior; (4) senior; (5) other
2. Grade you feel you will receive: (1) A; (2) B; (3) C; (4) D; (5) F; (6) Incomplete (I)
3. Grade you feel you should receive: (1) A; (b) B; (3) C; (4) D; (5) F; (6) Incomplete(I)
4. Major area: (1) Life sciences; (2) physical science and math; (3) arts and humanities; (4) engineering; (5) agriculture; (6) home economics; (7) education
5. Age: (1) 20 or under; (2) 21-25; (3) 26-30; (4) 31-39; (5) 40 or older
6. Student's expected grade point this quarter: (1) 3.5 or up; (2) 3.0-3.5; (3) 2.0-2.9; (4) 1.0-1.9; (5) below 1.0.
7. Reason for taking course? (1) requirement for life sciences major; (2) to fulfill group or college requirements; (3) just interested; (4) don't know.
8. How many credits have you taken in other college level courses in the life sciences: (1) 0; (2) 3-5 credits; (3) 5-10; (4) 10-15; (5) more than 15.
9. How many credits have you taken in college level courses in the physical sciences (Chem;Physics;Geol.): (1) 0; (2) 3-5; (3) 5-10; (4) 10-15; (5) more than 15.

10. Are you currently enrolled in any of the following courses: (1) 101A; (2) 102A; (3) 102B; (4) 103; (5) more than one of the above.

11. How many hours per week did you spend on Biology 101 outside of class? (1) 1 hr; (2) 2-4 hr; (3) 5-6 hr; (4) 7-8 hr; (5) 9 hr or more.

12. How many lectures did you miss during the quarter? (1) 0; (2) 2; (3) 4; (4) 6; (5) 7 or more.

Opinions about Course (Use 1 to 9 scale on cover page; do not use 0)

13. The textbook was not suitable for this course.

14. Ventilation, seating arrangements, and lighting were adequate in the lecture halls used in this course.

15. The study guide was of little use in preparing for the examinations.

16. Old tests from previous quarters are the best way to prepare for the examinations in this course.

17. Compared to other courses I took this quarter, I found myself spending too much time on Biology 101 for the college credit assigned.

18. It was important to me to have the study guide in order to organize the subject material.

19. In this course, cramming for tests was the most effective means to obtain a high grade.

20. Tests were useful to me as a learning aid.

21. The tests were an adequate measure of my knowledge of Biology 101 and will allow the instructor to assign me the grade I deserve.

22. In this course the final grade will be more related to intelligence than to study effort expended.

23. I felt that I could determine my grade in this course more than in most other courses at I.S.U.

24. Compared to other courses at I.S.U., the tests in this course were more threatening.

25. Too much emphasis was placed on testing and grades in this course.

26. I adjusted my study habits during the course according to the scores I received on tests.

27. The course allowed me to pursue in depth understanding in areas that personally interested me.

28. I feel that this course should be recommended only for life science majors.

29. I had to officially drop other courses from my schedule in order to keep up with the work in this course.

30. During the latter half of this course I had an accurate impression of the grade that I would receive.

31. I feel that this course has not contributed significantly to my understanding of the basic processes of living systems.

32. My personal interest in biology was high before taking this course.

33. The number of exams was not adequate to test my understanding and keep my interest.

34. The exams in this course were unfair and tricky.

35. Exams in this course emphasize factual material at the expense of understanding concepts.

36. My personal interest in biology was high after taking this course.

37. Regardless of my grade, I feel that I have mastered the relevant content of Biology 101.

38. I frequently used the tape recordings in the Library to review the course material.

39. I was aware that Biology 101 was taught this quarter using two different methods (PAS and Traditional).

40. From what I know about the other way of teaching the course, I would prefer to be in the other type of section.

41. The grade standards in this course are too high.

42. During the course, my interest in biology developed to the point that I wanted to spend more time on Biology 101 than I had originally expected.

43. This course has encouraged me to develop good study habits.

44. This course has encouraged me to develop critical reading skills.

45. I was disappointed that Biology 101 dealt with abstract biological processes and not the structure and function of plants and animals.

46. My final grade in this course will be limited because I lack a background in the sciences.

47. I was unable to master the abstract generalizations demanded in this course.

48. This course has stimulated my desire to take additional biology courses.

49. I think that this is one of the worst courses I have had at I.S.U.

50. This course forced me to regard myself as being unable to comprehend the basic concepts of biology.

Opinion of Instructor

51. The instructor did not interpret abstract ideas and theories clearly.

52. The instructor contributed to my interest in his subject.

53. The instructor has increased my skills in thinking.

54. The instructor has helped broaden my interests.

55. The instructor does not stress important material.

56. The instructor makes good use of examples and illustrations.

57. The instructor has not motivated me to do my best work.

58. The instructor does not inspire class confidence by his knowledge of the subject material.

59. The instructor has given me new viewpoints and appreciations.

60. The instructor is not clear and understandable in his explanations.

Return the questionnaire and completed answer sheet on Wednesday, Nov. 20, at 9:45 at your final examination.